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CENTRAL INTELLIGENCE AGENCY 25X1 [redacted]

INFORMATION REPORT

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[redacted] The results described below apply to the corrosive action on different metals and alloys of concentrated nitric acid, called HOKO, (hochkonzentriert), the concentration being between 99% and 100%; of Salbei 20, main oxygen carrier for turbine motors, consisting of 97% HNO_3 and 3% $FeCl_2$; and of highly concentrated (81 to 83%) hydrogen peroxide, main oxygen carrier for rockets and jets.

2. Investigation of the corrosive action of HOKO and Salbei 20 bore on steel and refined steel, pure aluminum, and aluminum alloys. The samples under investigation had average dimensions of 100mm by 20mm by 2mm. Prior to the test, the samples were cleansed with ethyl alcohol, dried and weighed. The average duration of the test was 14 days; it was carried out at ambient temperature (about 20° C) as well as at 50° C. The desired temperature was produced in a water-filled tank approximately 40cm by 40cm by 15cm. At its lower end, the tank was provided with a heating installation. The tank was made of V_2A steel (18% chromium, 8% nickel, the rest being iron and refining matter). A cylindrical container, made of Jena glass, with a diameter of about 12cm and a height of about 35cm and equipped with a contact thermometer, was placed in the middle of the tank (see envelope 1, containing a photo of the container)*. Metal samples to be tested were inserted into the container filled with either of the mentioned oxygen carriers and hermetically closed for the duration of the test at the end of which the samples were cleansed in water, dried in alcohol and, after four hours, weighed for the determination of the loss in weight caused by corrosion. The corrosion rate was expressed in grams/square meter/day (24 hours).

3. HOKO and Salbei 20 showed identical corrosive action with respect to steel and refined steel. The corrosion rate for ordinary steel and low-grade steel alloys (up to 4% alloying supplement) varied between 20 and 100 grams/meter square/day. Armco iron (iron containing less than 0.1% C) showed the relatively good

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rate of only 5 grams/meter square/day at ambient temperature. However, at 50° C, ordinary steel, low-grade steel alloys and Armco iron suffered from corrosive attack to such an extent that they had to be entirely eliminated as usable materials. Usability for the purposes in question could be determined only with Austen chromium steel having a chromium content of 13% and more. Particularly good results were obtained with 18/8 chromium-nickel steel (steel containing 18% chromium and 8% nickel, produced as V2A steel by Krupp and as Remanit by Vereinigte Stahlwerke): at ambient temperature they showed practically no corrosion at all, only discoloring. At 50° C, chromium steel (from 13% chromium upward) and chromium-nickel steel showed good results; the corrosion rate was less than 1 gram/square meter/day. Surface and diffusion protection turned out to be entirely inadequate as anti-corrosive agents. Samples into which protective agents, such as silicium compounds, were diffused and phosphated samples (treated with phosphoric acid) showed high corrosion rates.

4. With respect to pure aluminum (technically pure, 99.5%) and to aluminum alloys, HOKO and Salbei 20 showed essentially the same results. Unlike steel and steel alloys, aluminum and aluminum alloys were tested in two different ways: a. in static tests (as described above) and b. in circulation tests; the temperature again was either ambient or 50° C. The average duration of static tests was 300 hours, and of circulation tests, 60 hours. The circulation test was carried out with a cylindrical container of Jena glass approximately 20cm in diameter and 40cm tall, containing the attacking fluid (HOKO or Salbei 20); at its bottom, it had an outlet connected to a centrifugal pump driven by an electromotor. When in operation, the pump drove the attacking fluid through a glass column and, from there, back into the cylindrical container. The glass column was provided with a number (up to five) of tabulated flasks in succession; each flask could be hermetically closed with an Oppanol** plug through which a thermometer reached into the flask. The flasks were surrounded by heating spirals made of constantan or manganine wrapped in asbestos. Samples of the metals to be tested were inserted into the flasks which were then closed and the attacking fluid was driven through by action of the centrifugal pump. It turned out that the results of static tests as well as of circulation tests differed essentially from each other depending on the age of the attacking fluid. If the attacking fluid was applied to pure aluminum immediately or shortly after arrival from its place of manufacture (IG Farben plant in Bitterfeld), the corrosion rate remained under 0.5 grams/square meter/day. Recast aluminum (recast from aluminum scrap, designated "Fliegwerkstoff" FlW 3001, pure aluminum being FlW 3000) exposed to fresh HOKO or Salbei 20 had a rate of about 1 gram/square meter/day; Pantal (FlW 3355, an Al-Mg-Mn-Si alloy, with Mn as the main alloying substance), 2 to 3 grams; various kinds of hydronalium (FlW 3305, 3310, 3315, alloys of the same substances, with Mg as the main alloying substance), up to 5 grams; Duralumin (FlW 3115, an Al-Cu-Mg alloy, with Cu as the main alloying substance), about 6 grams and less; Silumin (Al with 13% Si) between 8 and 10 grams/square meter/day. Aluminum-plated Duralumin (FlW 3116, being FlW 3115 with a layer of FlW 3000 on each side, both layers constituting about 40% of the entire material) had a corrosion rate varying between 1 and 5 grams/square meter/day. These tests were all carried out at ambient temperature. When pure aluminum and various aluminum alloys were exposed to the attacking fluid in circulation tests at 50° C, white crystals appeared on the metal samples after about 40 hours. These crystals increased rapidly, so much so that, at one time, a blade of the centrifugal pump was blocked and broken by them. The crystals had a melting point of 80° C; analysis determined their composition to be $(AlNO_3)_3 \cdot 9H_2O$. Formation of the crystals was caused through incorporation of water from the air into the attacking fluids when the receptacles containing them were opened and also through inevitable contact with air humidity during circulation tests, particularly at increased temperature, when the flasks had to be opened repeatedly to insert the metal samples. Aluminum nitrate crystals also showed up during static tests, even though the containers were hermetically closed, when the attacking fluid used had been stored for some time. They also appeared on steel during static

tests with attacking fluids which had been stored for some time. In the latter case, the aluminum contained in the crystals stemmed from the storage containers. A series of tests determined the following relations: attacking fluid stored for a long period (4 weeks and more) provoked rapid formation of such crystals in static tests on pure aluminum and aluminum alloys, sometimes as quickly as within six hours. Attacking fluid which had been stored for five or six days only, however, caused such crystals to appear in slight quantities only and not earlier than after two days. To clarify this point still further, samples were exposed to attacking fluid of five days' storage in containers of 250ccm (static test) for two days or longer until the crystals started to appear; 10ccm of H_2O were then added to some of the containers; the others were left undisturbed. Within the next few days, formation of crystals was much heavier in those containers to which water had been added. Formation of the crystals developed into a major problem, since, in practice, it is very difficult to isolate the attacking fluid completely from air humidity. Use of concentrated nitric acid as oxygen carrier for anti-aircraft rockets was not recommended by the Rechlin Institute for this reason. (Envelope 2 contains a photo of crystals, one-and-one-half times enlarged).*

5. The Rechlin Institute obtained hydrogen peroxide for the tests from underground plants in Thuringia, near Rudolstadt. A plant near Kahla, Thuringia, and the firm of Schickert and Co., Bad Lauterberg am Harz, also produce it in the required concentration. The H_2O_2 was furnished in 20-liter cans of oxidized pure aluminum, in a concentration varying between 81 and 83%. (Oxidation of the aluminum was done by electrolysis, the aluminum acting as anode, whereby a thin, protective skin of Al_2O_3 was formed on the metal). To reduce the danger of explosive disintegration, the H_2O_2 was stabilized with 3% phosphoric acid. Even so, this oxygen carrier (also called T-stuff, as opposed to C-stuff, a designation applied to the fuel proper of rocket and jet motors) was highly sensitive; a few drops were sufficient to ignite inflammable material such as paper, cardboard, non-impregnated wood, or to cause skin burns, etc. Tests were carried out in 400-ccm containers of Jena glass provided with curved lids (Uhrglas Deckel) which were put into water tanks at constant temperatures; the test temperatures were 20° and 40° C. Tests with steel and most steel alloys were soon discontinued, because at both temperatures the concentration of the H_2O_2 dropped to 50% and less within 24 hours. However, the concentration did not decrease to less than 70% within four days when 18/8 chromium-nickel steel and 30% chromium steel were exposed. At 20° C, pure aluminum caused a decrease of concentration, after two days, to 79%; Pantal, Hydronalium alloys and Duralumin, to 60%. At 40° C, the concentration of H_2O_2 went down to 76% in the same period with pure aluminum, whereas it dropped to around 50% with aluminum alloys.

6. As mentioned above, the procedure of oxidation by electrolysis was used to protect aluminum against the action of H_2O_2. However, the German aircraft industry was unable to solve the technological difficulties connected with the mass production of H_2O_2 tanks electrolytically oxidized on the inside; therefore, other protective measures were looked for and tested. At the Karlshagen-Peenemünde Research Service of the Luftwaffe, Dr. (fnu) Demant developed and patented an oxygenation process based on the reaction of various organic acids, such as citric acid, on aluminum whereby oxyquinone is precipitated on the aluminum. This process was adopted and carried out by the producers of H_2O_2 tanks; it turned out to be a failure, however, because numerous tests proved that the protective layer contained pores and, thus, was unable to act as an efficient protection against H_2O_2.

7. Studies made at Rechlin with ground sections of pure aluminum and oxygenated aluminum samples proved an important point: the T-stuff invariably attacked crystals imbedded as impurities in the aluminum, such as Mg_2Si, $CuAl_2$, Al_3Fe, etc. Unprotected heterogeneous aluminum alloys were therefore ruled out as material for H_2O_2 tanks. At the end of the war, aluminum of highest purity was considered to be the best material for such tanks.

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** [redacted] Comment: Oppanol is synthetic rubber produced by IG Oppau and the Görlitz rubber plant.

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